Structure of the ePTM

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The enhanced Particle Tracking Model (ePTM)

- Physical transport module – fish affected by hydrologic flow through the system
- Behavioral module – behavioral responses of fish to environmental variables (e.g., tides, time of day)
- Ecological module – fish live or die based on interactions with predators

Why build a mechanistic simulation model?

Salmon behave very differently from “passive particles”

Why build a mechanistic simulation model?

Could use a correlational analysis (e.g., regression of survival on mean flow)

Four primary advantages:

(1) Use knowledge from other domains (e.g. hydrology)

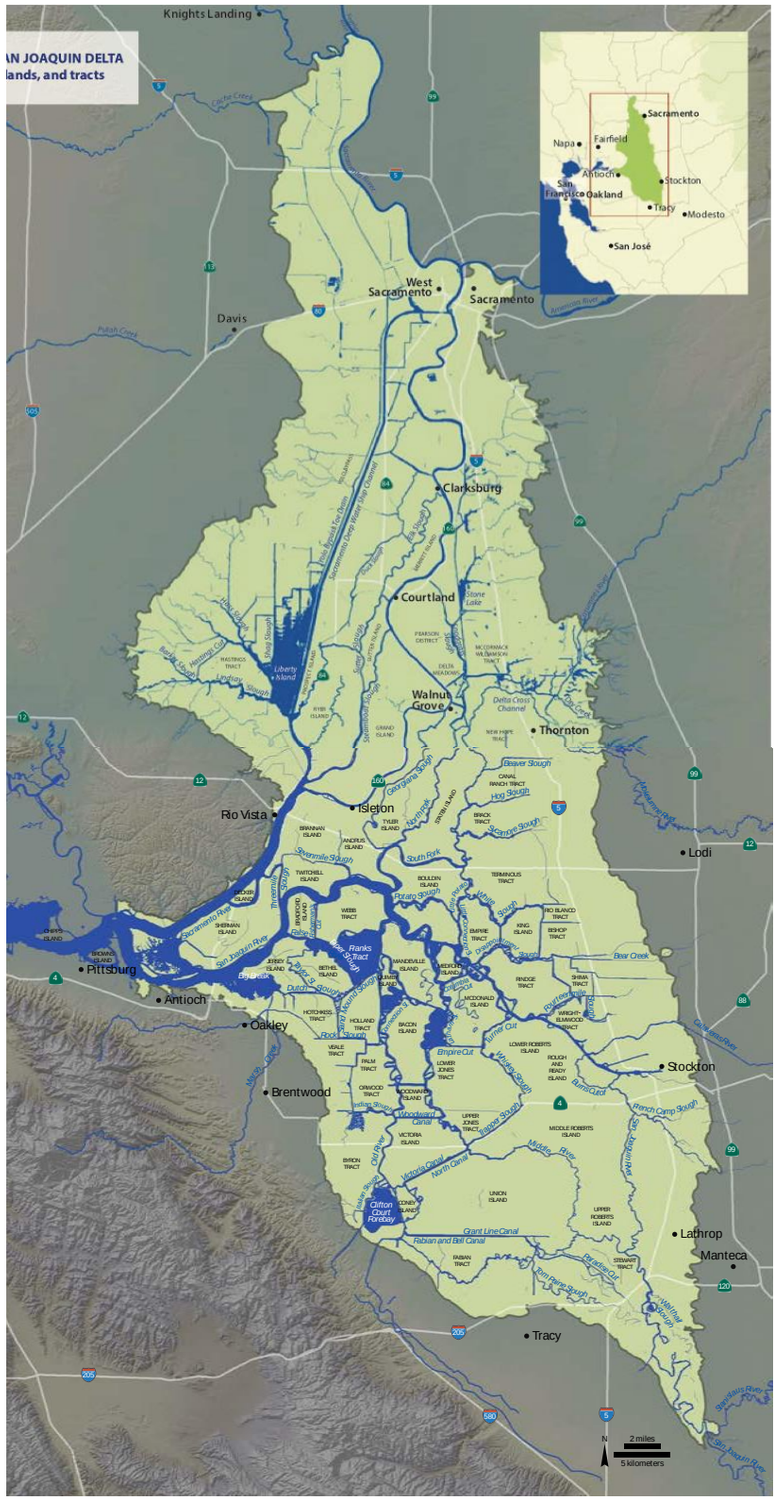
(2) Make predictions under new conditions (anticipate disasters)

(3) Explore both fine-scale and large-scale drivers

(4) Incorporate new information as it becomes available

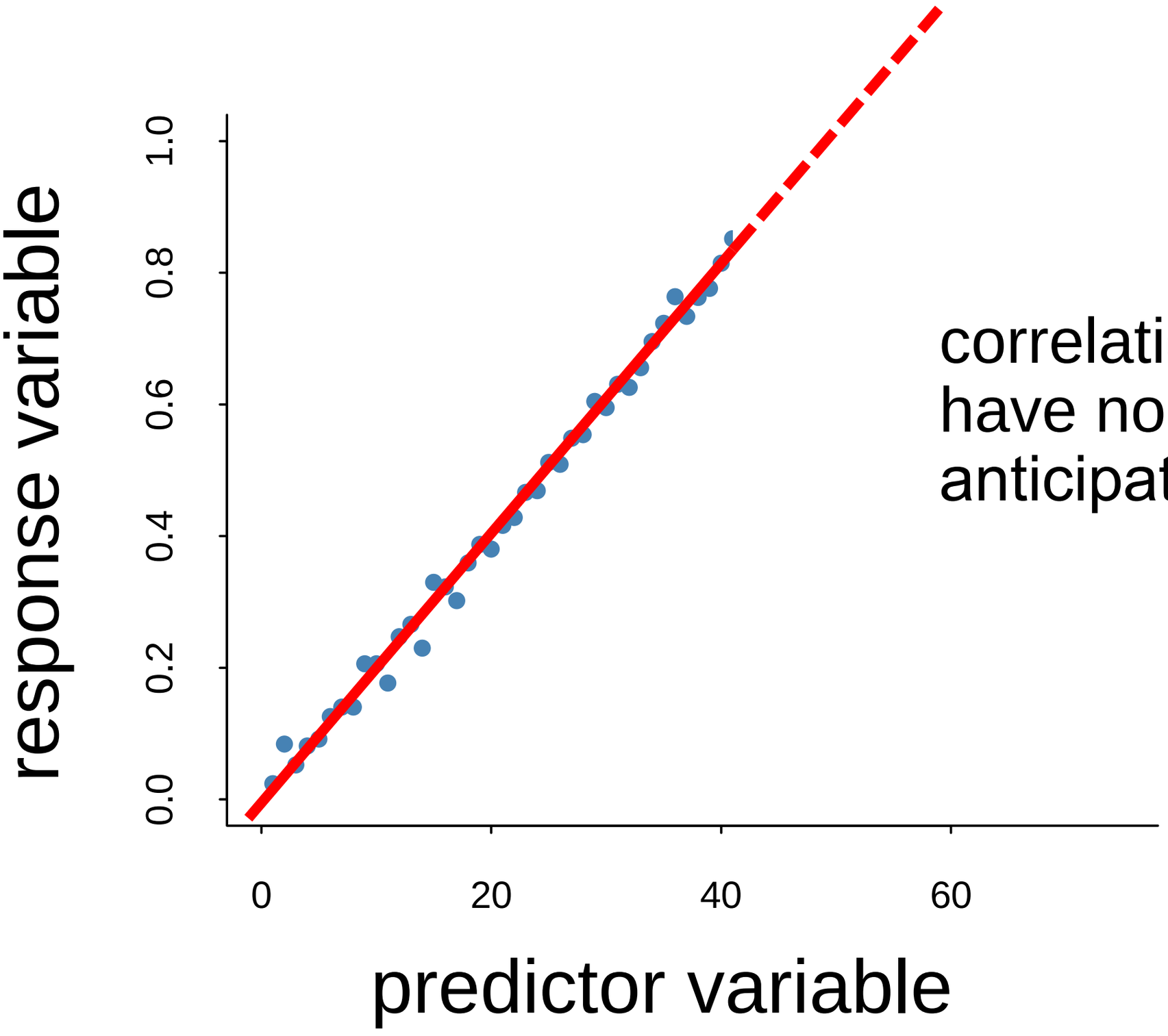
(1) Use knowledge from other domains

Take advantage of extensive hydrologic studies/models



SF Estuary Institute

(2) Make predictions under new conditions



correlational models have no hope of anticipating “disasters”

(3) Explore both fine-scale and large-scale drivers

(4) Incorporate new information as it becomes available

Chapman et al. 2013 Env. Biol. Fish.

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Physical transport module:

- Much like PTM, each simulated fish is subject to advection and diffusion

- Flows are based on DSM2 Hydro

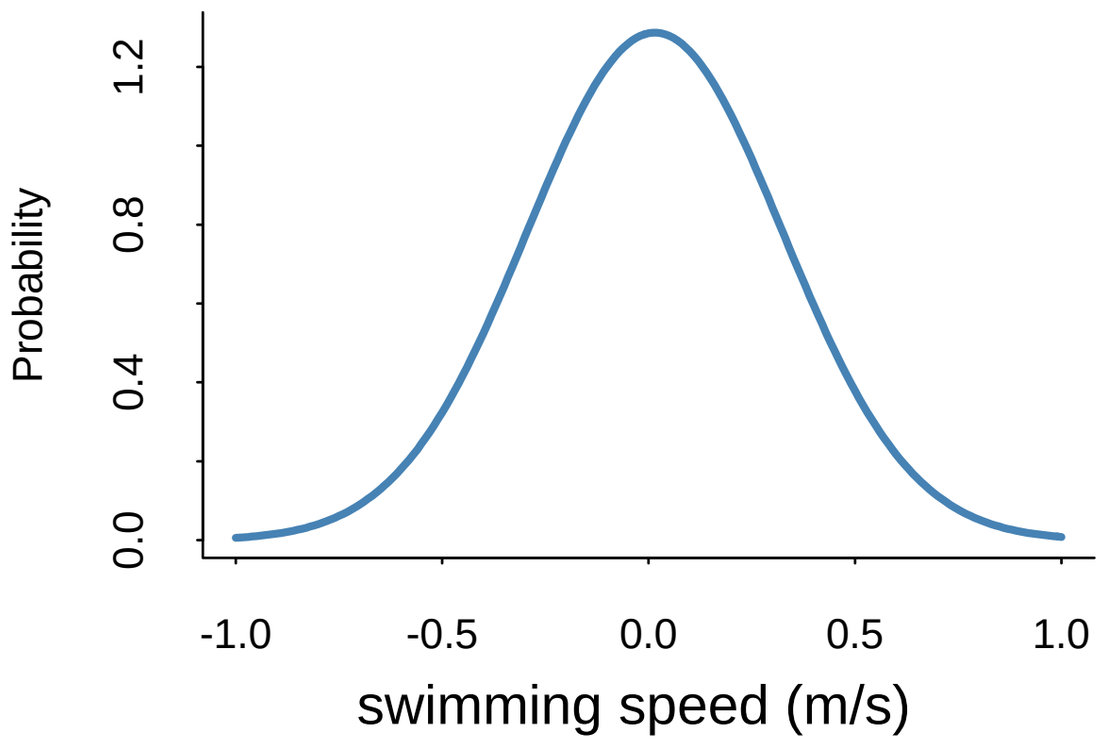
- Fish are routed at junctions in proportion to flow split

Fish behavior module:

- Active swimming
- Flow-dependent holding
- Mis-assessing mean flow (i.e., “confusion”)
- Daytime holding

Active swimming

- Fish swim in addition to being moved by flows
- Modeled by drawing a swimming speed, U_s, from a normal distribution with the mean and variance fitted to data.
- Each fish has a different value of U_s (m/s)



Flow-dependent holding behavior

- Animals that migrate through tidal systems often hold during one phase of the tide.
- Referred to as “selective tidal stream transport”
- This behavior is modeled by a threshold on flow, U_T, above which, fish hold position.

(Creutzberg 1960; Healey 1967; Gibson 2003).

Probability of mis-assessing downstream direction

- Referred to as “confusion” in some of the ePTM documentation. Probability that a fish will mis-identify downstream direction.
- Fitted as a function of the ratio of mean flow to short-duration variation in flow (e.g., tides). Variation over 2 tidal cycles.

range in delta

P(mis-assess downstream flow)

0.5
0.4
0.3
0.2
0.1
0

-10
-5
0
5

log(mean flow/variation in flow)

Daytime holding

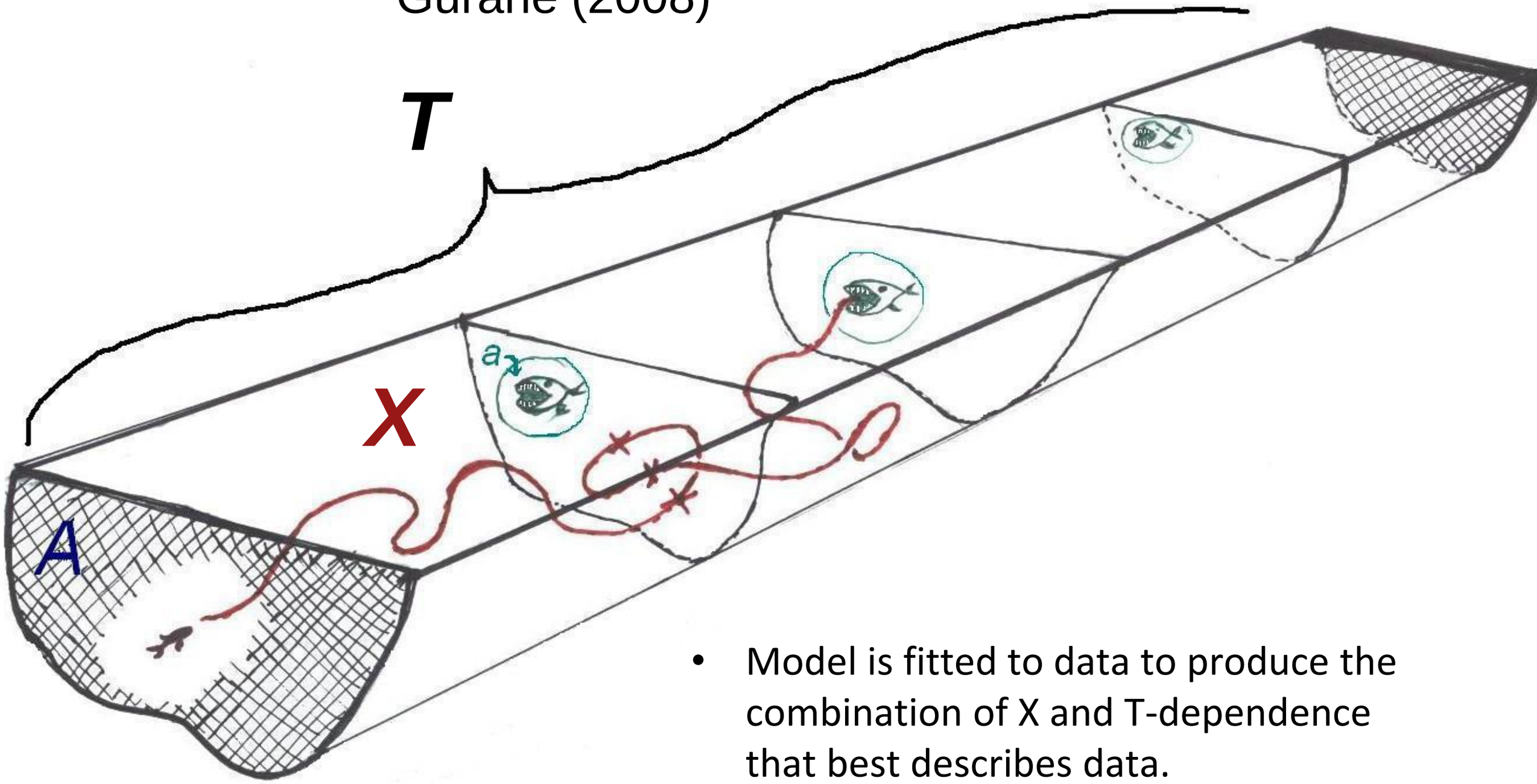
- Chinook known to migrate primarily at night (Chapman et al. 2013)
- Probability of migrating during the day changes from riverine to tidal regions.
- Modeled by fitting probability of daytime migration to data for riverine, transitional, and tidal reaches

Ecological module:

- Predators are a major source of mortality in the Delta
- Model encounters between outmigrating salmon and predators using a modified version of the “XT model” (Anderson et al. 2005)
- Predation risk is a function of the distance a fish travels (X) and the time taken to travel that distance (T)

The XT Model Cartoon

Gurarie (2008)



- Model is fitted to data to produce the combination of X and T-dependence that best describes data.

Anderson et al 2005 Ecol. Mod.